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J. CUMMING

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SYLLABUS
OF
A COURSE
OF
CHEMICAL LECTURES.

BY

JAMES CUMMING, M.A. F.R.S. M.G.S.

A VICE PRESIDENT OF THE CAMBRIDGE PHILOSOPHICAL SOCIETY;
AND PROFESSOR OF CHEMISTRY IN THE
UNIVERSITY OF CAMBRIDGE.



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OBJECTS OF CHEMISTRY

DIVIDED INTO

	Art.
Imponderable Agents.	Heat 11—20
	Light 21—25
	Electricity, Magnetism, Galvanism 359-392
Supporters of Combustion.	Oxygen 30
	Chlorine 91
	Iodine 101

FORMING ACIDS.

Non-Metallic Combustible bases.	{	Nitrogen	29
		Hydrogen	35
		Sulphur	63
		Selenium	71
		Carbon	73
		Phosphorus	82
		Boron	88

FORMING ALKALIES.

{	Potassium	42
	Sodium	46
	Lithium	50

FORMING EARTHS.

Metallic Combustible	{	Calcium, the base of Lime	115
		Barium Barytes	129
		Strontium Strontia	136
		_____ ? _____ Magnesia	123
		_____ ? _____ Alumina	143
		_____ ? _____ Glucina	147
		_____ ? _____ Yttria	148
		_____ ? _____ Zirconia	149
		_____ ? _____ Thorina	150
		_____ ? _____ Silica	152

It is a very secret Science, for none almost can understand the language of it. Sublimation, Almigation, Calcination, Rubification, Encorporation, Circination, Sementation, Albification, and Frementation. With as many termes impossible to be uttered, as the Arte to bee compassed.

John Lilly's Gallathea.

The new nomenclature of Chemistry seems to furnish a striking illustration, of the effect of appropriate and well defined expressions, in aiding the intellectual powers.

Dugald Stewart.

Complexity almost always belongs to the early epochs of every Science.—The more the phenomena of the Universe are studied, the more distinct their connection appears, the more simple their causes, the more magnificent their design, and the more wonderful the wisdom and power of their Author.

Sir H. Davy.

SYLLABUS,

&c.



INTRODUCTION.

1. **DISTINCTION** between Mechanical and Chemical philosophy : definition and objects of Chemistry : analysis and synthesis. General view of elementary substances ; different principles of classification ; arrangement for Lectures, and reasons for adopting it.

ATTRACTION.

2. *Attraction of Cohesion* : counteracted by heat and solution.
3. *Crystallization* : by reduction of temperature ; by evaporation : water of crystallization ; efflorescence ; deliquescence, &c.
4. Circumstances which affect the formation of crystals ; different susceptibilities of crys-

tallization in different salts; application to chemical analysis; pseudomorphous crystals.

5. *History of Crystallography*: analysis and synthesis of the structure of crystals: theory of Haüy: primary and secondary forms: hypothesis of spheroidal particles: Goniometers.
6. *Chemical Attraction*: distinguished from the attraction of cohesion: the results of its action, condensation, change of temperature: its application to the analysis and synthesis of substances.
7. Relative forces of Affinity: simple: compound: tables of affinity: modifications in their practical use.
8. Limits of chemical attraction, as to the proportions and number of combining substances: opinions of Berthollet on determinate proportions: Richter's law of the mutual decomposition of Salts.
9. *Theory of Atoms*: of volumes: equivalents: Wollaston's scale.
10. *Chemical Apparatus*: names and uses: modern improvements in experimental chemistry.

CALORIC.

11. *Free Caloric* : the effects of caloric opposed to those of attraction : expansion : fluidity : evaporation.
12. Equilibrium of heat : Thermometers of air, alcohol, mercury : Pyrometers : principles of graduation : nature and limits of the information derived from them.
13. Law of expansion in solids, fluids, airs ; experiments of Dulong and Petit : exception in water ; its beneficial effects and probable cause.
14. Diffusion of heat by contact : different conducting power of solids ; its application : conducting power of fluids, of airs ; effects in preserving equability of temperature.
15. Diffusion of heat by radiation : reflexion and refraction of heat : effect of different surfaces on radiation and absorption : practical application : differential Thermometer : apparent radiation of cold : Ethrioscope.
16. *Specific Caloric* : specific heat of different bodies : distinguished from absolute heat :

comparative : modes of ascertaining : affected by condensation and rarefaction.

17. Specific heat of the same body in different forms : discoveries of Dr. Black : latent heat of solids, fluids, airs : affected by pressure : estimate of the elastic force of vapours : application of Steam to mechanical purposes.
18. Absorption of heat by liquefaction of salts : transfer of heat by evaporation, of ether, of water : discovery of Leslie : Cryophorus.
19. Evolution of heat by the crystallization of salts ; by chemical combination : application of the doctrine of latent heat to natural phenomena and artificial processes.
20. The nature and sources of heat : theory of combined caloric ; of vibrations : heat by friction and percussion, how explained : attempts to ascertain the weight and absolute zero of heat.

LIGHT.

21. Solar light separated into heating, illuminating and deoxidizing rays : experiment of Morrichini.
22. Analogies of heat and light : Photometers :

evolution of light by phosphorescence, attrition, chemical combination.

23. Polarisation of light by Refraction, through Iceland Spar, Tourmaline, Glass: law by Dr. Brewster.
24. Polarisation by Reflection: discovery by Malus: polarising plate: analysing plate: depolarising substances, natural and artificial: law of the polarising angle.
25. Application of polarised light to Crystallography.

ATMOSPHERIC AIR,

And its ELEMENTS.

26. Nature and general properties of aeriform substances: distinction of vapours and gases erroneous: apparatus and modes of manipulation for the gases.
27. *Atmospheric air*, not elementary; composed of indivisible particles; its constitution and general properties; Barometrical Thermometer.
28. Analysis of the air by Eudiometers; separation of Carbonic acid; tests of aqueous

vapour by Hygrometers; theories of the formation of Rain and Dew.

29. *Nitrogen* (14) obtained by the decomposition of atmospheric air; by other processes; its general and distinctive properties and combinations; opinions as to its composition.
30. *Oxygen* (8); the discovery of it; different modes of procuring; general properties; power in supporting animal life and combustion; tendency to combination; nomenclature of its compounds; not the sole cause of acidity; its electrical relations.
31. *Theories of Combustion*, by Stahl, Lavoisier, Davy; evolution of heat and light, how accounted for.

WATER AND ITS BASE.

32. Properties of Water; compressibility; crystallization; absorbability of gases; tests of its impurities; erroneous opinions of its nature; its chemical combinations, hydrates.
33. *Water* (9), decomposed by different processes; effects of the discovery on Chemical Science.
34. Synthesis of water by Priestley and Cavendish;

experiments of the French Chemists; ambiguous results, how avoided.

35. *Hydrogen* (1); modes of obtaining it; impurities; general and distinctive properties; inflammability; tenuity; levity; balloons; effects in the production and propagation of sounds; chemical affinities; natural sources.
36. *Deutoxide of Hydrogen* (17); discovered by Thenard; its properties.

ALKALIES,

Their BASES and COMBINATIONS.

37. Classification and distinguishing properties of Alkalies; their affinities.

AMMONIA.

38. Preparation of Ammonia; its general and peculiar properties; aeriform, absorbable by Water; modes of examining; comparative affinity to acids.
39. *Ammonia* (17) analysed in part by Priestley and Scheele; analysis completed by Berthollet; effects of metals in promoting the decomposition.

40. Synthesis* of Ammonia, by Milner and Higgins ; natural causes of its formation ; anomalous experiment of Berzelius.

POTASSA.

41. Practical preparation and purification of Potash ; its properties and combinations ; mineral sources.
42. *Potassium* (40), the base of Potassa ; its discovery ; process for obtaining it ; its nature and properties ; affinity for oxygen ; utility in Chemical research.
43. Synthesis of Potassa ; protoxide of Potassium (48) ; hydrate of Potassa (57) ; peroxide of Potassium (64).
44. Compounds of Potassium with Hydrogen.

SODA.

45. Preparation of Soda ; its properties and combinations ; how distinguished from Potash ; native ; mineral sources.
46. *Sodium* (24), the base of Soda ; its formation and distinctive properties.
47. Synthesis of Soda ; protoxide of Sodium (32) ;

hydrate of Soda (41); peroxide of Sodium (36).

48. Compound of Sodium and Nitrogen.

LITHIA.

49. Discovery of Lithia; its analogy with Potash and Soda; how distinguished; its sources.

50. *Lithium* (10); *Lithia* (18); *Analysis and Synthesis*.

ACIDS,

Their BASES *and* COMBINATIONS.

51. Enumeration of the simple acidifiable bases; their general and distinctive characters and combinations.

52. General properties of Acids; their composition, classification and nomenclature.

53. The nature and nomenclature of their combinations.

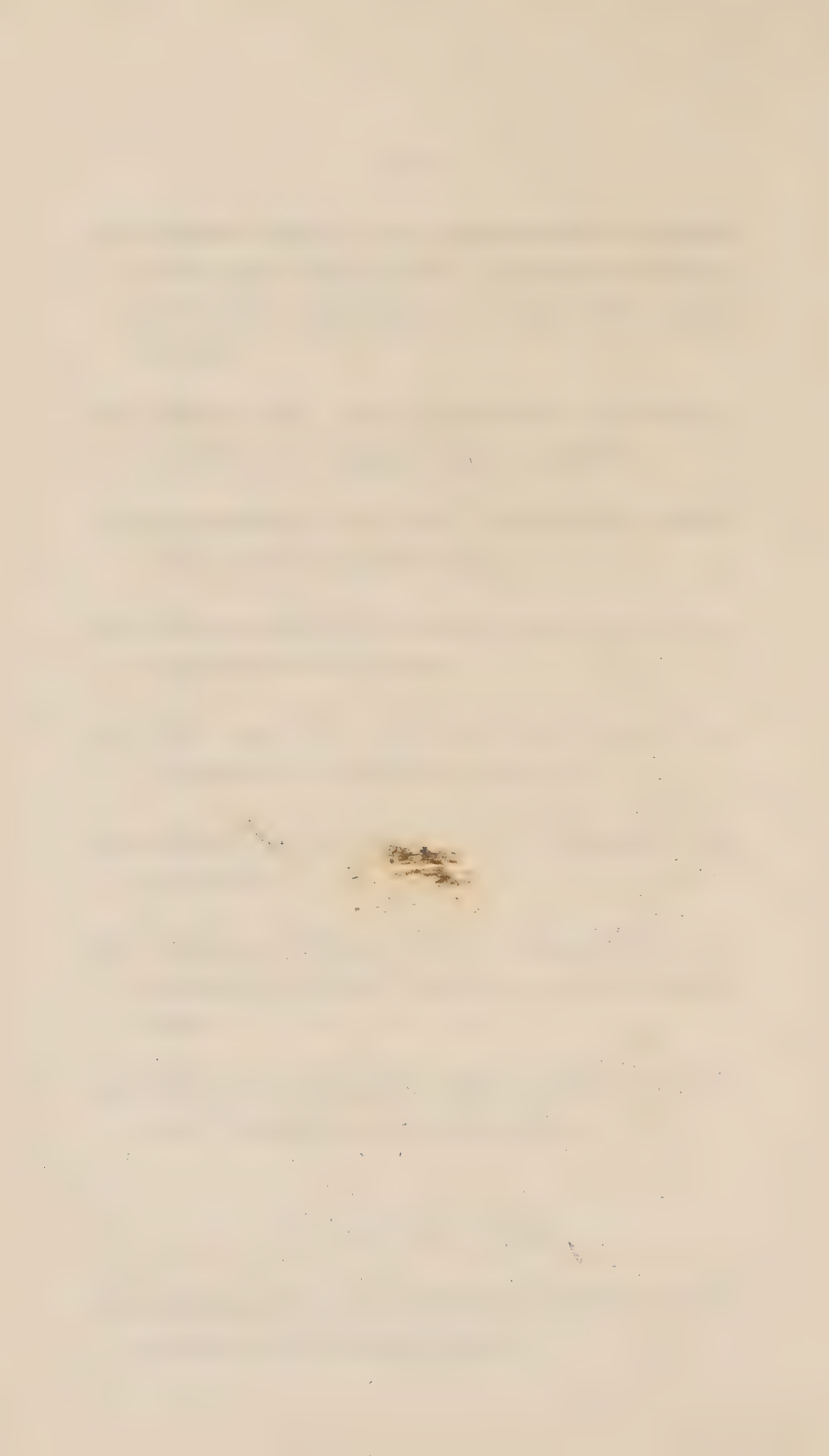
NITRIC ACID.

54. Process for procuring liquid Nitric acid; purification and properties; tests; susceptibility of decomposition.

55. *Nitrous oxide* (22); preparation; composition and decomposition; general properties; effects in combustion and on the animal system.
56. *Nitric oxide* (30); preparation; qualities; attraction for oxygen; decomposition.
57. *Hyponitrous acid* (38); formation; combination with Sulphuric acid.
58. *Nitrous acid* (46); formation and properties; combination with water.
59. *Nitric acid* (54); formation and properties; synthesis by Cavendish; analysis.
60. *Nitrate of Ammonia* (71); formation and properties.
61. *Nitrate of Potash* (102); composition; natural and artificial formation; properties and uses.
62. *Nitrates of Soda and Lithia* (86) and (72); their formation and composition.

SULPHURIC ACID.

63. *Sulphur* (16); properties and sources; compounds with alkaline bases.



64. *Sulphureted Hydrogen* (17); formation and general characters; tests; acid properties; combinations and uses in analysis; decomposition.
65. Compounds of sulphur and hydrogen, with alkaline bases.
66. *Sulphuric acid* (40); liquid (49); formation and properties; purifications; tests; decomposition.
67. *Sulphates* of Ammonia (57); Potash (88); Soda (72); Lithia (58); their composition, properties and uses.
68. *Sulphurous acid* (32); preparation; form and properties; compound with nitric oxide; tests and uses; decomposition.
69. Compounds of sulphurous acid with alkaline bases.
70. *Hyposulphurous and Hyposulphuric acids* (24) and (32); their composition.

SELENIC ACID.

71. *Selenium* (41)? discovery by Berzelius; peculiar properties and tests; opinions as to its nature.

72. *Selenic acid* (57); Selenic oxide; Seleniates; Selenurets; their composition and properties.

CARBONIC ACID.

73. *Carbon* (6); preparation and general properties, and uses; power in absorbing gases and moisture; conjecture by Newton and verification by Tennant, of the nature of the diamond.
74. *Cyanogen* (26); discovery by Gay Lussac; preparation and qualities.
75. *Hydro-cyanic acid* (27); formation; properties and combinations with alkalies; uses in analysis.
76. *Carbureted Hydrogen* (8); natural and artificial formation and properties.
77. *Bi-carbureted hydrogen* (7); preparation and decomposition.
78. *Sulphuret of Carbon* (38); formation and properties; power in producing cold; decomposition.
79. *Carbonic acid* (22); formation and peculiar properties; sources and natural decomposition; tests; analysis.

80. *Carbonates and bi-carbonates* of Ammonia (39 and 61); Potash (70 and 92); Soda (54 and 76); Lithia (40); their composition, properties and uses.
81. *Carbonic oxide* (14); formation, properties and decomposition.

PHOSPHORIC ACID.

82. *Phosphorus* (12); discovery; preparation and purification; properties; application to Eudiometry.
83. *Phosphureted and bi-phosphureted* hydrogen (14) and (13); their preparations; properties and composition.
84. *Phosphurets* of sulphur, selenium and carbon.
85. *Phosphoric acid* (28); by combustion of phosphorus; other processes; properties; tests; analysis and synthesis.
86. *Phosphates* of Ammonia (45); Potash (76); Soda (60); Lithia (46); their preparation, composition and uses.
87. *Phosphorous and hypo-phosphorous acids* (20) and (32); their formation; properties; composition and combinations.

BORACIC ACID.

88. *Boron* (6)? discovery by Davy; preparation and properties.
89. *Boracic acid* (22)? preparation; properties; tests; composition.
90. *Borate* of Ammonia (39)? Sub-borates of Potash and Soda (70 and 54)? their preparation and composition; natural sources of sub-borate of Soda; its uses.

CHLORIC ACID.

91. *Chlorine* (36); discovered by Scheele; preparation: form and general properties; tests; analogies with oxygen; opinions as to its constitution; practical application by Berthollet.
92. *Chloride of Nitrogen* (158)? discovery by Dulong; preparation; facility of decomposition.
93. *Protoxide of Chlorine* (44); formation and properties; tests; anomaly in its decomposition.

94. *Peroxide of Chlorine* (68); discovery by Davy; preparation and properties; decomposition by phosphorus.
95. *Chloric and perchloric acids* (76), (100); their preparation; properties and combinations.
96. *Chlorates and perchlorates* of Ammonia (); Potash (124 and 131); Soda (108); preparation and general properties; action with inflammables.
97. *Compounds of Chlorine* with sulphur (52)? Carbon (120, 42, 48); Phosphorus (48, 84).

HYDROCHLORIC ACID.

98. *Hydrochloric (muriatic) acid gas* (37); preparation; general and distinctive characters; analysis and synthesis; statement and supposed proofs, of the theories as to its composition.
99. *Liquid muriatic acid*; preparation; properties; tests.
100. *Muriates* of Ammonia (53); Potash (76); Soda (60); Lithia (46); their formation and natural sources; uses; composition, considered as chlorides or as muriates.

IODIC ACID.

101. *Iodine* (125); discovery by Courtois; preparation and properties; tests; sources; analogies with oxygen, chlorine and sulphur.
102. *Iodide of Nitrogen* ; preparation.
103. *Iodic acid* (165); formation; properties; decomposition.
104. *Iodates* of Ammonia (182), Potash (213), Soda (197); their formation and properties.
105. *Hydriodic acid* (126); composition and decomposition ; properties ; tests.
106. *Hydriodates* of Ammonia (143), Potash (174), Soda (158); their formation and properties.
107. *Iodides* of Potassium (165), Sodium (169), Lithium (135), Sulphur (141).
108. *Chloriodic acid*; its preparation and combinations.

FLUORIC ACID.

109. *Fluorine* (16)? attempts to ascertain its nature; probable analogies with Chlorine and Iodine.
110. *Hydrofluoric acid* (17)? preparation and peculiar properties; combinations and uses.
111. *Fluoboric acid*; formation and peculiar properties; combinations.

EARTHS,

Their BASES *and* COMBINATIONS.

112. General properties of the Earths; analogies and distinctions between the Earths, Alkalies and Metallic Oxides.

LIME.

113. *Lime* (28); preparation and general properties; hydrate (37); tests; sources and uses.
114. *Combinations* of Lime with Sulphur and Phosphorus.
115. *Calcium* (20); discovery and preparation; protoxide; peroxide.

116. *Nitrate of Lime* (82) ; formation, properties and uses.
117. *Sulphate of Lime* (68) ; composition and natural sources ; properties ; uses.
118. *Carbonate of Lime* (50) ; sources ; composition and decomposition ; solubility in Carbonic acid ; crystallization by heat ; uses.
119. *Phosphate and fluuate of Lime* (56) and (61) ? their mineral and animal sources ; properties.
120. *Muriate of Lime* (65) ; composition and properties ; application of Chloride of Calcium to bleaching ; assay.
121. *Compounds of Lime with Boracic, Iodic and other acids.*

MAGNESIA.

122. *Magnesia* (20) ; preparation and properties ; sources ; tests ; tendency to form triple combinations ; uses.
123. *Magnesium* (12) ; discovery incomplete.
124. *Sulphate of Magnesia* (60) ; natural and artificial formation ; properties and uses.

125. *Carbonate of Magnesia* (42); preparation and uses.
126. *Muriate of Magnesia* (57); composition and natural sources.
127. *Triple Salts of Magnesia*; their natural and artificial formation and uses.
128. Miscellaneous combinations of Magnesia.

BARYTES.

129. *Barytes* (78); preparation from its Nitrate; general properties; strong affinity for water; crystallization; tests; native combinations.
130. *Barium* (70); process for its discovery; protoxide; peroxide (86); its application by Thenard.
131. *Nitrate of Barytes* (132); preparation and composition.
132. *Sulphate of Barytes* (118); properties and composition; natural sources; decomposition; phosphorescence.
133. *Carbonate of Barytes* (100); native and artificial; properties; decomposition by heat and acids.

134. *Muriate and Chlorate of Barytes* (78) and (154); preparation and chemical uses.
135. Miscellaneous Barytic compounds.

STRONTIA.

136. *Strontia* (52); preparation and distinctive properties; crystallization; tests; native combinations.
137. *Strontium* (44); process for obtaining it from the native carbonate; properties.
138. *Nitrate of Strontia* (106); formation; peculiar properties; decomposition.
139. *Sulphate of Strontia* (92); composition and decomposition; distinguished from Sulphate of Barytes; sources.
140. *Carbonate of Strontia* (74); natural and artificial formation; composition and properties.
141. *Muriate of Strontia* (80); preparation; crystallization; properties and uses.
142. Miscellaneous combinations of Strontia.

ALUMINA.

143. *Alumina* (18); preparation from Alum; sources and native forms; general properties; solubility in alkalies; affinity for water and colouring matter; contraction by heat; tests; presumptive proof of its decomposition.
144. *Combinations of Alumina* with Earths and metallic oxides; their uses.
145. *Sulphate of Alumina* (58); preparation and test.
146. *Sulphate of Alumina and Potash (Alum)*; formation and composition; uses; decomposition by Charcoal, Pyrophorus.

GLUCINA.

147. *Glucina* (26)? native combinations and discovery by Vauquelin; process; analogies with Alumina; distinctive properties.

YTTRIA.

148. *Yttria* (40)? sources and discovery by Gadolin; general and distinctive characters.

ZIRCONIA.

149. *Zirconia* (45); native combinations and discovery by Klaproth; general properties; analogy with oxide of Titanium.

THORINA.

150. *Thorina* () ; natural source and discovery by Berzelius; general and distinctive properties.
151. Presumptive proofs of metallic bases in Glucina, Yttria, Zirconia and Thorina.

SILICA.

152. *Silica* (16)? natural sources and preparation; precaution in analysis; general and distinctive characters; tests; opinions as to its composition.
153. *Combinations of Silica* with Alkalies, Earths and metallic oxides; their preparation and uses.
154. *Silicated fluoric acid* (24)? formation and general properties; decomposition by water; combinations with Ammonia and Potassium.

METALS.

155. *General characters* of the metals ; lustre ; opacity ; conductors of heat and electricity ; high specific gravity, exceptions ; fusibility.
156. *Distinctive characters* ; affinities for oxygen ; electrical relations ; malleability ; volatility ; power of acidification, &c.
157. *Native state* ; separation from impurities ; reduction.
158. *Combinations* ; general character of metallic oxides and salts ; compounds with alkalies and inflammable bases ; alloys.

MALLEABLE METALS,

PLATINA.

159. *Platina* (96) ; natural history ; purification and preparation.
160. *Properties* general and distinctive ; specific gravity 22.0 ; tests.
161. *Perchloride* (142) ; formation and precipitation by Muriate of Ammonia ; ammonio-

muriate (196) and triple salts ; action of precipitated Platina on Hydrogen ; application to Eudiometry.

162. *Sulphuret and Sulphate* ; their preparation ; precipitation of Sulphuret by Alcohol and Ammonia ; properties of the precipitates.
163. *Alloys* ; their general properties ; fusibility ; action of acids.
164. *Uses* ; general ; chemical, its limitation ; formation of fine Platina wires.

PALLADIUM.

165. *Palladium* (56) ; native ; united with Platina ; discovery and separation by Wollaston ; process.
166. *Properties* general and distinctive ; Sp. G. 11.2 ; tests.
167. *Combinations with acids* ; precipitation by alkalies, by metals.
168. *Combinations* with alkalies ; with Sulphur (72) ; their properties.
169. *Alloy* with Gold ; its properties and practical application.

RHODIUM.

170. *Rhodium* (); discovery and separation from Platina; process.
171. *Properties* general and distinctive; Sp. G. 11.0; alloy with Steel.
172. *Chloride* of Rhodium (); preparation and properties.

IRIDIUM.

173. *Iridium* (); united with Platina; discovery and separation by Tennant; process.
174. *Properties*; colour of its acid solution; precipitation by alkalies and metals; fusibility; Sp. G. 18.68; alloys.

OSMIUM.

175. *Osmium* (120)? discovered with Iridium; process for its separation; native ore of Iridium and Osmium, Sp. G. 19.5.
176. *Properties*; high specific gravity; insolubility in acids; solubility in alkalies.
177. *Protoxide of Osmium* (128)? formation; volatility; odour; tests.

178. *Alloys* with Gold, Silver, Mercury.

GOLD.

179. *Gold* (200); ores; separation and purification.

180. *Properties*; Sp. G. 19.3; malleability; colour by transmitted light, &c.; tests.

181. *Salts*; Chlorides (236 and 272), by solution in Chlorine and aqua regia; preparation and properties; action of precipitants; results; revival of Gold by inflammables.

182. *Compounds*; Oxide (224); Sulphuret (248); alloys; their formation and properties.

183. *Uses*; in coinage, assay; gilding; painting on glass and porcelain, &c.; test of nitric acid.

SILVER.

184. *Silver* (110); native combinations; extraction, reduction and purification.

185. *Properties*; Sp. G. 10.51; malleability &c.; tests.

186. *Salts*; Nitrate (172); Sulphate (158); Carbonate (140); Phosphate (146); Chloride (146); their preparation and properties.

187. *Compounds*. Oxide (118); Sulphuret (126); combination with Ammonia and Oxalic acid; alloys with Copper, Mercury, Steel, &c.; their formation and properties.
188. *Uses*; in coinage, cupellation; plate, recovery of Silver by Nitro-sulphuric acid; medicine, &c.

MERCURY.

189. *Mercury* (200); native combinations; separation and purification.
190. *Properties*; Sp. G. 13.56; aeriform, fluid, solid, &c.; tests.
191. *Salts*; Nitrates (262 and 324); Sulphates (248 and 296); Chlorides (236 and 272); their formation and properties; precipitates, &c.
192. *Compounds*; Oxides (208 and 216); Sulphurets (216 and 232); Bicyanuret (252); amalgams, &c.; their formation and properties.
193. *Uses*; in extraction of Gold and Silver; gilding; medicine, &c.

COPPER.

194. *Copper* (64) ; native forms ; extraction and purification.
195. *Properties* ; Sp. G. 8.8 ; malleability ; ductility, &c. ; tests.
196. *Salts* ; Pernitrate (188) ; Persulphate (160) ; Carbonate ; Chlorides (100 and 136) ; their formation and properties ; precipitants.
197. *Compounds* ; Oxides (72 and 80) ; Sulphurets (80 and 96) ; Ammoniuret, &c. ; alloys with Lead, Tin, Zinc ; their formation and properties.
198. *Uses* ; in coin ; brass, bronze ; sheathing of ships, its preservation, &c. &c.

IRON.

199. *Iron* (28) ; Ores ; extraction, reduction and purification ; Meteoric Iron, its history and composition.
200. *Properties* ; Sp. G. 7.8 ; welding ; ductility ; magnetism, &c. ; tests and modes of separating from other metals.
201. *Salts* ; Nitrates () ; Sulphates (76, 100,

- 200); Carbonate (58); Chlorides (64 and 82); Ferro-cyanate; their formation and properties; precipitates, &c.
202. *Compounds*; Oxides (36 and 40); Sulphuret (44); combinations with alkalies; alloys; their preparation and properties.
203. *Uses*; in Steel, its formation and properties; tinning; miscellaneous uses of Iron.

LEAD.

204. *Lead* (104); native combinations; separation and reduction.
205. *Properties*; Sp. G. 11.36; malleability &c.; tests.
206. *Salts*; Nitrate (166); Sulphate (152); Carbonate (134); Phosphate (140); Chloride (140), &c. &c.; their preparation, properties and precipitates.
207. *Compounds*; Oxides (112, 116, 120); Sulphuret (120); Phosphuret (116), &c.; alloys; their formation and properties.
208. *Uses*; in cupellation; glass making; medicine, &c. &c.

TIN.

209. *Tin* (59); native state; reduction.
210. *Properties*; Sp. G. 7.3; malleability; imperfect elasticity, &c.; tests.
211. *Salts*; Nitrate; Sulphate; Muricates (104 and 171); Nitromuriate; Chlorides (195 and 131); their preparation and properties.
212. *Compounds*; Oxides (67 and 75); Sulphurets (75 and 91); combinations with alkalies; alloys; their formation and properties.
213. *Uses*; in dyeing; enamelling; silvering mirrors; bell-metal, &c.

ZINC.

214. *Zinc* (33); native combinations; reduction and purification.
215. *Properties*; Sp. G. 7.0; malleable and ductile at 300°; volatility &c.; tests.
216. *Salts*; Nitrate (95); Sulphate (81); Carbonate (63); Chloride (69); their preparation, properties and precipitates.

217. *Compounds* ; Oxide (41) ; Sulphuret ; Phosphuret ; combinations with hydrogen and alkalies ; alloys ; their formation and properties.
218. *Uses* ; in alloy with Copper and Tin ; medicine ; galvanism, &c.

CADMIUM.

219. *Cadmium* (56) ; its discovery by Stromeyer ; native combinations ; extraction and separation from other metals.
220. *Properties* ; Sp. G. 9.0 ; malleability, volatility, &c. ; tests.
221. *Salts* ; Nitrate (118) ; Sulphate (104) ; Chloride (92) ; Iodide (181) ; their properties and precipitates.
222. *Compounds* ; Oxide (64) ; Sulphuret (72) ; alloys ; their properties.

NICKEL.

223. *Nickel* (30) ; meteoric ; other native combinations ; separation, reduction and purification.
224. *Properties* ; Sp. G. 8.9 ; malleability ; ductility ; magnetism, &c. ; tests.

225. *Salts* ; Nitrate (92) ; Sulphate (78) ; Chloride (66) ; their formation, properties and precipitates.

226. *Compounds* ; Oxide (38) ; Sulphate (46) ; Ammoniuret ; alloys ; their properties.

BRITTLE AND EASILY FUSED.

BISMUTH.

227. *Bismuth* ; (71) ; native state ; reduction and purification.

228. *Properties* ; Sp. G. 9.8 ; structure, crystallization, &c. ; tests.

229. *Salts* ; Nitrate (133) ; Sulphate (119) ; Chloride (107) ; their formation ; precipitation by water ; properties.

230. *Compounds* ; Oxide (79) ; Sulphuret (87) ; alloys ; their properties.

231. *Uses* ; In soldering, painting, medicine, &c.

ANTIMONY.

232. *Antimony* (44) ; discovery ; native state ; reduction and purification.

233. *Properties* ; Sp. G. 6.7 ; texture ; crystallization ; volatility, &c. ; tests.
234. *Salts* ; with nitric and sulphuric acids ; chloride (80) ; their formation ; precipitation by water and alkaline sulphurets.
235. *Compounds* ; oxides (52 and 60) ; sulphuret (60) ; Hydrosulphuretted oxide ; alloys ; their preparation and properties.
236. *Uses* ; In printers' types ; medicine, &c.

TELLURIUM.

237. *Tellurium* (58) ; discovery by Klaproth ; extraction from the ore ; sublimation.
238. *Properties* ; Sp. G. 6.18 ; texture ; volatility, &c. ; tests.
239. *Salts* ; with nitric and nitro-muriatic acids ; chloride (74) ; their properties and precipitates.
240. *Compounds* ; oxide (46) ; its distinctive character ; tellurates ; telluretted hydrogen, solid and gaseous ; its formation and properties.

ARSENIC.

241. *Arsenic* (38); native combinations; reduction.
242. *Properties*; Sp. G. 8.31; volatility; odour, &c.; tests.
243. *Acids of Arsenic*; arsenious acid (54); arsenic acid (62); their formation and properties.
244. *Salts of arsenical acids*; arsenites of Silver, of Copper; arsenites of Ammonia (79); Potash (110); Soda (74); their preparation and properties.
245. *Compounds of Arsenic*; Chloride (100); Sulphurets (54 and 62); arsenuretted hydrogen; their formation and properties.
246. *Uses*; in glass-making; painting; speculum metal; medicine, &c.

BRITTLE AND DIFFICULTLY
FUSED.

COBALT.

247. *Cobalt* (30); meteoric; other native combinations; separation and reduction.

248. *Properties* ; Sp. G. 7.7 ; Magnetic ; tests, &c.
249. *Salts* ; Nitrate (92) ; Phosphate (66) ; nitromuriate, &c. ; their preparation and properties.
250. *Compounds* ; chloride (66) ; Sulphuret (46) ; alloys.
251. *Uses* ; in glass, porcelain, &c.

MANGANESE.

252. *Manganese* (28) ; native state ; separation of impurities ; reduction.
253. *Properties* ; Sp. G. 8.0 ; texture ; strong affinity for oxygen ; tests.
254. *Salts* ; Sulphate (76) ; Carbonate (58) ; Chloride (64) ; their formation and properties ; manganesiates.
255. *Compounds* ; oxides (36, 40, 44) ; black oxide, with borax and nitre, with unctuous substances ; properties.
256. *Uses* ; in bleaching ; glass-making, &c.

CHROMIUM.

257. *Chromium* (28); discovery by Vauquelin ;
meteoric ; mineral forms ; reduction.
258. *Properties* ; Sp. G. 5.9 ; Colour, &c. ; tests.
259. *Chromic acid* (52) ; chromates of potash
(100 and 152) ; chromates of mercury, lead,
&c. ; their formation and properties.
260. *Compounds* ; oxide (36), &c.
261. *Uses* ; in painting, calico-printing, &c.

MOLYBDENUM.

262. *Molybdenum* (47) ; native state ; reduction.
263. *Properties* ; Sp. G. 8.6 ; soluble in nitric
and nitromuriatic acids, and chlorine ; tests.
264. *Molybdic acid* (71) ; molybdous acid (63) ;
oxide of molybdenum (55) ; their formation
and properties.

URANIUM.

265. *Uranium* (125)? discovery by Klaproth ;
native combination ; reduction.

266. *Properties* ; Sp. G. 9.0 ; tests, &c.
267. *Salts* ; nitrate ; sulphate ; their formation and precipitates.
268. *Compounds*, protoxide (133)? peroxide (137)?

TUNGSTEN.

269. *Tungsten* (96) ; united with lime ; with iron and manganese ; separation and reduction.
270. *Properties* ; Sp. G. 17.4 ; colour, &c. ; tests.
271. *Compounds* ; protoxide (112) ; peroxide or tungstic acid (120) ; bisulphuret (128) ; their formation and properties.

TITANIUM.

272. *Titanium* () ; discovery in menachanite, by Gregor ; in iron slag, by Wollaston ; other sources ; separation and reduction.
273. *Properties* ; Sp. G. 5.3 ; crystallization ; colour ; insolubility in acids ; magnetism ? tests.
274. *Compounds*. Oxide by heat with nitre ; process ; solution in acids ; precipitation.

COLUMBIUM.

275. *Columbium* (144); discovery by Hatchet; native sources; reduction by Berzelius.
276. *Properties*; Sp. G. 5.61? porosity, insolubility in acids; tests.
277. *Compounds*; oxide, by fusion with potash and solution in acids; process, &c.

CERIUM.

278. *Cerium* (92); discovery by Berzelius and Hisinger; sources; preparation and reduction by Vauquelin.
279. *Properties*; Sp. G.? soluble in nitromuriatic acid; volatile? tests.
280. *Salts*; Nitrate, Sulphate, Muriate; their formation, properties and precipitates.
281. *Compounds*; protoxide (108); peroxide (116); their formation.

VEGETABLE SUBSTANCES.

282. Formation of vegetable substances ; distinction between organic and inorganic compounds ; chemical physiology of vegetables ; their proximate and ultimate principles.

ULTIMATE ANALYSIS.

283. Imperfection of ancient methods ; modern, by peroxide of Copper ; process ; mode of collecting and estimating the results ; general conclusions ; peculiarity in the atomic constitution of vegetables.

PROXIMATE ANALYSIS.

284. Natural and artificial proximate analysis ; agents ; character and classification of the results.

NEUTRAL

VEGETABLE COMPOUNDS.

285. *Extract* ; its preparation and general properties ; solvents ; affinity for alumina and metallic oxides.

286. *Gum* (90); composition and properties; solvents; action of acids; products.
287. *Sugar* (81); natural sources and preparation of saccharine juices; composition and properties of sugar; its effects on metallic salts; action of solvents and acids.
288. *Starch* (101)? preparation and properties; composition; action of solvents and acids; conversion of Starch into Sugar, theory of the process; test of Iodine.
289. *Gluten*; its preparation and peculiar properties.
290. *Caoutchouc* (20); native sources; properties; solvents.
291. *Tannin*; sources and native combinations; preparation and properties; solution in alcohol and precipitation by acids; compounds with metallic oxides; test of gelatine. Synthesis of tannin by Hatchet.
292. *Colouring matter*; distinction of substantive and adjective colours; mordants, their use and mode of action; preparation and properties of Indigo, &c.; affinity of colouring matter for alumina, lakes.
293. *Fixed Oils*; obtained by pressure; their

composition and general properties ; solvents ; combinations with alkalies, with metallic oxides ; action of acids and carbonaceous substances.

294. *Volatile Oils* ; by distillation ; distinction between fixed and volatile oils and test ; general properties ; solvents ; action of acids ; combinations with Sulphur and Phosphorus.
295. *Wax* (97) ; Vegetable and animal sources ; composition and properties ; compounds with alkalies, with fixed oils.
296. *Camphor* (77) ; native sources ; composition and properties ; solution in alcohol and oils ; action of nitric acid ; camphorates. Synthesis of camphor, by the action of muriatic acid on essential oil of turpentine.
297. *Resins, gum resins, &c.* their sources ; composition and general properties ; solvents ; distinction between Resins and Gums ; action of nitric acid on resins, peculiarity in the result. Their uses in medicine and in the arts.

NATIVE VEGETABLE ALKALIES.

298. *Native vegetable alkalies* ; powerful medical action of their natural combinations ; recent discovery of their preparation ; their relative power in neutralizing acids ; other general properties.
299. *Morphia* ; prepared from Opium by Derosne ; different processes ; crystallization ; general properties ; solvents ; medical effects.
300. *Strychnia* ; native sources ; preparation ; crystallization ; general properties ; medical effects.
301. *Atropia* ; from the *Atropa belladonna* ; preparation ; general properties ; solvents ; characters of its Salts ; medical effects.
302. *Veratria* ; united with Gallic acid in the *Colchicum autumnale*, &c. ; preparation ; general properties ; solubility in Alcohol ; medical effects.
303. *Cinchonia* and *Quinia* ; from Peruvian bark ; their preparation ; Salts of Cinchonia, of Quinia ; their characteristic properties ; uses in medicine.

304. *Delphia, Picrotoxia, &c.*; their preparation and properties.

NATIVE VEGETABLE ACIDS.

305. *Native vegetable acids*; their general character and composition; weak affinities of their component principles; mutual convertibility by the action of nitric acid, &c.
306. *Oxalic acid* (36); native source; artificial preparation from Sugar, &c.; process; form, composition and general characters; deleterious effects; oxalates of Ammonia, Potash, Soda; other oxalates; test of Lime; other uses.
307. *Citric acid* (58); discovery and preparation by Scheele; properties; citrates; uses in Calico printing, &c.
308. *Malic acid* (60); native sources; discovery and preparation; composition; properties; malates.
309. *Gallic acid* (63); native combinations; separation; purification; composition; properties; solvents; uses in chemistry as a precipitant, in dyeing, inks, &c.

310. *Tartaric acid* (66); native combination with potash; separation and purification; composition; properties; tartrate and supertartrate of potash (114 and 130), of potash and soda (212)? of potash and Antimony (284)? pyrotartrates; their preparation; medical and other uses.
311. *Benzoic acid* (120); preparation from Gum benzoin and other sources; composition and properties; Benzoate of Ammonia; other benzoates; uses in chemical analysis.
312. *Succinic acid* (50); not strictly a native acid; preparation from Amber; composition and properties; Succinate of Ammonia; other Succinates; uses in chemical analysis.

SPONTANEOUS DECOMPOSITION OF VEGETABLE SUBSTANCES, AND RESULTS.

313. *Vinous fermentation*; from the reaction of vegetable constituents on each other; precedes the acetous and putrefactive fermentations; nature of the process; results.
314. *Alcohol* (46); a constituent of fermented liquors; separation by distillation and other modes; preparation and purification; gene-

ral properties ; chemical combination with water ; solvent powers ; decomposition ; proximate and ultimate constituents, compared with those of Sugar.

315. *Ether* ; preparation of Sulphuric Ether (37) ; other Ethers ; purification and general properties of sulphuric Ether ; volatility, &c. ; solvent powers ; detonated with oxygen and chlorine ; slow combustion by Platina, result ; decomposition ; constituents compared with those of Alcohol.
316. *Acetous fermentation* ; distinguished from vinous ; process ; results.
317. *Acetous and acetic* (50) *acids* ; by fermentation, by distillation of wood ; other processes ; general properties ; decomposition and constituents of acetic acid.
318. *Acetates* ; of Ammonia () ; potash (98) ; soda (82) ; lime (78) ; other acetates ; their preparation, composition and properties ; uses in medicine, calico printing, &c.

BITUMINOUS SUBSTANCES.

319. *Bituminous substances* ; their mineral sources ; probability of their vegetable origin ;

chemical composition and general properties.

320. *Naphtha* (41)? sources, natural and artificial; properties; analysis; chemical uses.
321. *Naphthaline* (13); from the decomposition of coal; its purification, crystallization, &c.
322. *Petroleum*; *mineral tar*, &c.; their nature and properties.
323. *Asphaltum*; discovery in Trinidad; other sources; composition and properties; solvents; uses, in varnishes, Greek fire? &c.
324. *Elastic bitumen*; in Derbyshire; history; peculiar properties; solution in petroleum.
325. *Retinasphaltum*; in Bovey Coal; distinctive characters.
326. *Coal*; distinctions of Brown, Black and Glance Coals; their composition; peculiar characters and properties.
327. *Coal gas*; history of its discovery and practical application; present process of its preparation and distribution; gaseous products; purification; solid and liquid results; their purification and uses.

328. *Oil gas* ; its preparation and purification ; gas-meters ; portable gas ; comparison of light and heat from coal and oil gases ; their relative advantages ; analysis of the gases by Chlorine.
329. *Nature of flame* ; its high temperature ; distinction between light and heat of flame ; difference of combustibility of carburetted hydrogen, hydrogen, sulphur, phosphorus ; its cause ; extinction of flame by rarefaction, by incombustible gases, by metallic surfaces.
330. *Safety lamp*. History of fire-damp, its nature and destructive effects ; attempts to prevent them ; invention of the Safety lamp and experiments which led to its discovery ; improvements and practical application ; theory of its action.
331. *Invisible combustion* ; of vapour of Ether and Alcohol, of oxygen and hydrogen, by platina at low temperatures ; experiments of Davy and Dobereiner ; application to safety lamp, to Eudiometry. Probable causes of these phenomena.

ANIMAL SUBSTANCES.

332. *Animal compounds*; their general composition and chemical properties; distinguished from vegetable compounds; products of their spontaneous decomposition; modes of proximate and ultimate analysis. Results from proximate analysis of animal compounds.
333. *Gelatine* (180); Its preparation and general properties; action of acids; of alkalies; precipitation by tannin; analysis. Analogy of gelatine and mucus.
334. *Albumen* (180); its composition; coagulation by heat, by alcohol, by acids and metallic salts; cause of its coagulation; precipitation by prussiate of potash; decomposition by tannin.
335. *Fibrin* (204); its preparation and properties; action of alcohol, of acids; solution in alkalies; composition.
336. *Blood*. Effects of respiration on the animal system; animal heat; experiments of Brodie; venous and arterial blood; serum, crassamentum, their proximate constituents; colouring matter; form of globules; ultimate constituents of blood; its uses in the animal system. Preparation of Prussian blue.

337. *Milk*; its proximate constituents; coagulation, &c.; caseic, lactic and Saccholactic acids (105); ultimate analysis.
338. *Animal Oils*; distinction between vegetable and animal oils: Whale oil (105); Spermaceti oil (77), their history and composition; Adipocire, produced from animal muscle; natural and artificial process, properties; separation of fat into Stearin and Elain; Sebacic acid; artificial production of fat from gaseous substances.
339. *Animal resins*; from Bile; Cerumen; Ambergris; Castor, &c.; their general and peculiar properties.
340. *Gastric juice*; its peculiar coagulating and solvent properties, &c.; existence of free muriatic acid in the human stomach.
341. *Bile and biliary calculi*; general properties and composition of Bile; Picromel, its preparation and properties. Composition of biliary calculi; solution in alcohol, crystallization; Cholesterine, its distinguishing properties.
342. *Urine*; its composition in different classes of animals; modifications by disease; detection and separation of its constituents.

343. *Urinary calculi*; their chemical history, constituents and classification.
344. *Calculi of uric acid, and urate of ammonia*; their general form, colour and internal structure; composition; *tests*, by the blow-pipe, by the action of acids and alkalies, by colour with nitric acid. Preparation of purpuric acid and urea by Prout, their properties.
345. *Calculi of ammoniaco-magnesian phosphate*; external characters; crystallization; action of water, of acids; analysis by Wollaston; tests.
346. *Calculi of phosphate of lime*; external characters; action of acids; of the blow-pipe; tests.
347. *Calculi of phosphate of lime and magnesia with ammonia, (fusible calculi)*; their characters; analysis; test by the blow-pipe.
348. *Calculi of carbonate of lime*; characters and tests.
349. *Calculi of oxalate of lime (mulberry calculi)*; external characters; action of acids and alkaline carbonates; analysis; tests.
350. *Calculi of Cystic oxide*; discovery by Wol-

laston ; their peculiar external characters ; solvents and precipitants ; test by the blow-pipe.

351. *Calculi of xanthic oxide* ; discovery by Marcet ; distinguished from uric and cystic calculi.

352. *Bone, horn, shells, &c. &c.* ; constituents of bone ; their separation by heat, by dilute acids ; results, their uses ; analysis of teeth, fluoric acid ; composition of horn ; distinction between pearl and porcellaneous shells, &c.

353. *Putrefactive fermentation* ; common both to vegetable and animal substances ; processes by which it is retarded, their practical application ; progress of putrefaction ; results, gaseous and solid ; its utility in the economy of nature.

DETECTION OF POISONS.

354. *Organic poisons ; Vegetable* ; opium, essential oil of bitter almonds, &c. ; their detection by external characters ; chemical tests ; experiments of Brodie ; *Animal* ; difficulty in their discrimination ; defect in their chemical analysis.

355. *Inorganic poisons ; soluble* ; arsenic, corrosive sublimate, salts of Copper, nitrates of

Silver and Lead, nitrate and muriate of Barytes: *insoluble*; oxides of Mercury, carbonates of Lead and Barytes: their distinctive characters and tests.

356. *Mixed poisons*; emetic Tartar, acetates of Lead and Copper; oxalic and tartaric acids; their distinctive characters and tests.

ANALYSIS OF MINERALS AND MINERAL WATERS.

357. *Minerals*; comparative accuracy of modern analysis; causes; advantages of small analysis; apparatus; *preparatory examination*; distinction of mineral, vegetable, and animal substances; external characters of minerals, specific gravity, &c. &c.; the blow-pipe, its different forms and application; fluxes; supports; tests. — Fusion of the mineral with alkalies, &c.; separation of the constituents; examples.
358. *Mineral waters*; preliminary observations; sources, temperature, &c.; trial tests; collection and examination of gaseous products; examination of solid contents, by precipitation from a concentrated solution, by evaporation to dryness and redissolution. Pre-

cautions in filtration, in drying precipitates, &c.; probable errors from concentration; formula by Dr. Murray; application.

ELECTRO-CHEMISTRY.

359. *Etherial or imponderable substances applicable to Chemistry*; enumeration; mutual analogies; connection with chemical phenomena.

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360. History of the principal Electrical discoveries; electrical phenomena in nature; animal electricity.
361. *Electrical excitation*; by friction, change of temperature, contact of dissimilar substances; distinction of Electricities, positive and negative, resinous and vitreous; electrical attraction and repulsion.
362. *Electrics and non electrics*; distinction between them; enumeration of the principal; electrical properties independent on chemical.
363. *Electrical apparatus*; Electrometers; Elec-

trical machines; Leyden Jar, &c.; their construction and properties; Electrophorus; Condenser; theory of their action; inductive electricity.

364. *Chemical agency of Electricity*; analysis and synthesis of water and gaseous substances; transfer of chemical affinities; fusion and oxidation of metals.

365. Theories of Electrical excitation.

ELECTRO-MAGNETISM.

366. Supposed analogies between Electricity and Magnetism; experiments of Ritter and others; conjecture of Ørsted and his consequent discovery. Magnetism developed by chemical or electrical action, Electro-magnetism; by Heat, Thermo-electricity; discovery of Seebeck.

367. Action of a fixed horizontal or vertical conductor, on a magnetized bar in different positions.

368. Action of the bar on a conductor moveable round a horizontal axis.

369. Mutual action of two parallel conductors; comparison with that of parallel magnets.

370. Mutual action of a conductor and a transverse magnet.
371. Mutual action of two conductors moveable round a common vertical axis; compared with the action of a conductor and a magnet, and with that of two magnets similarly situated.
372. Action of terrestrial magnetism on moveable conductors; their position compared with the direction and dip of the compass needle.
373. Electro-magnetic rotation; experiments of Ampère, Faraday, Barlow, &c.; rotation of fluid conductors.
374. Rotation by Thermo-electricity; of a conductor round an interior magnet; of thermo-electric parallelograms, by external magnets.
375. Electro-magnetic Helices; their construction and modifications; analogies with the common magnet.
376. Magnetic polarity induced by Helices, in soft Iron, in Steel; by Galvanic action, by Electricity.
377. Construction of the Galvanoscope; its practical application; Galvanoscope of Gold leaf, its analogy with Bennet's Electrometer.

378. Comparison of Electric, Galvanic, Thermo-electric, and Ferruginous Magnetism.
379. Laws of Electro-magnetic action ; Electro-dynamics.
380. Theories of Electro-magnetic action ; application to terrestrial magnetism.

GALVANISM.

381. Discovery of Galvanism ; *tests* ; animal, chemical, magnetic.
382. Different Galvanic circles ; Thermo-electric series.
383. Discovery and structure of the Voltaic column and the Couronne des Tasses ; the Voltaic battery ; the Calorimotor ; different constructions of each and their respective advantages ; distinction between quantity and intensity of Galvanism.
384. Structure of the Electric Column ; its properties, compared with those of the Leyden Jar, the Voltaic pile, and the Thermo-electric battery.
385. Chemical agency of Galvanism, in the analysis of water and decomposition of Salts.

386. Decomposition of Alkaline and earthy oxides by the Voltaic battery ; discoveries of Davy.
387. Ignition and fusion of metals, &c., by the Voltaic battery, in vacuo ; in different gases.
388. Magnetic and chemical properties of the Voltaic arc of light.
389. Analogies of Heat, Light, Chemical Affinity, Electricity, Magnetism, and Galvanism.
390. Theories of Galvanic agency ; electro-motive, chemical, &c.
391. Theories of the action of the Voltaic pile.
392. Effects of Voltaic action on the animal system.

CONCLUSION.



